Australian National University

PUBLIC LECTURE

What makes plant photosynthetic membranes stick?

Wednesday 19 September 2012 1pm

Professor Fred Chow Division of Plant Science, Research School of Biology

Slatyer Seminar Room R. N. Robertson Building, Bldg 46, Linnaeus Rd, ANU

Photosynthetic membrane sacs (thylakoids) of plants form granal stacks interconnected by non-stacked thylakoids, thereby being able to fine-tune photosynthesis. Growth in low light leads to the formation of large grana, which sometimes contain as many as 160 thylakoids. The net surface charge of thylakoid membranes is negative, even in low-light-grown plants, so an attractive force is required to overcome the electrostatic repulsion. The theoretical van der Waals attraction is, however, at least 20-fold too small to play the role. We determined the enthalpy change (heat gained or lost at constant pressure), in the spontaneous stacking of previously unstacked thylakoids in the dark on addition of Mg^{2+}, to be zero or marginally positive (endothermic). The Gibbs free energy change for the spontaneous process is necessarily negative; therefore, an increase in entropy (disorder) is the only way to achieve such a negative Gibbs free energy change. We conclude that the dominant attractive force in thylakoid stacking is entropy-driven. Several mechanisms for increasing entropy upon stacking of thylakoid membranes in the dark, particularly in low-light plants, are discussed. On transition from dark to light, the chloroplast is driven far away from equilibrium, and granal stacking is altered. Whether this ultrastructural alteration maximizes the rate of entropy production is yet to be explored.

Presented by

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